

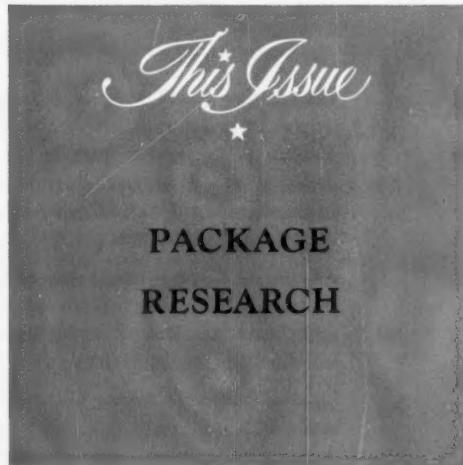
Volume 43

DECEMBER, 1957

Number 12

# Lubrication

A Technical Publication Devoted to  
the Selection and Use of Lubricants



PUBLISHED BY  
**THE TEXAS COMPANY**  
TEXACO PETROLEUM PRODUCTS



# For more Fun Afloat!



**Texaco Sky Chief Marine Gasoline:** It's supercharged—with Petrox, Texaco's petroleum-base additive. It's specially stabilized—to prevent gum in the fuel system or harmful deposits in the engine. Puts more pep and power into engines—inboard or outboard—than any other fuel. Protects against rust and wear.

**Advanced Custom-Made Havoline Motor Oil:** Choice of the racing champions. Extra heavy duty—for all gasoline and diesel inboards. Keeps engines clean for easy starts, full-flowing power. Prevents rust, fends off wear.

**Texaco Outboard Motor Oil:** Highly refined, straight mineral oil. Keeps rings free, ports clear, spark plugs clean. Assures easier starts, smoother operation.

**Texaco Outboard Gear Grease** or (for fluid lubrication) Texaco Outboard Gear Oil EP 90: Best protection for underwater gears and bearings from rust, corrosion and wear.

**And don't forget:** Texaco Cruising Charts, Texaco Mailport Service and the host of other helpful material your Texaco Waterfront Dealer can supply to help you have more fun afloat. The Texas Company, 135 East 42nd Street, New York 17, N. Y.

**THE TEXAS COMPANY**



# LUBRICATION

---

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

---

Published by

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

Copyright 1957 by The Texas Company

Copyright under International Copyright Convention.

All Rights Reserved under Pan-American Copyright Convention.

A. C. Long, Chairman of the Board of Directors; J. W. Foley, President; C. B. Barrett, E. R. Filley, T. A. Mangelsdorf, J. T. Wood, Jr., Senior Vice Presidents; S. C. Bartlett, J. B. Christian, S. T. Crossland, F. M. Dawson, H. T. Dodge, Oscar John Dorwin, Robert Fisher, F. H. Holmes, L. C. Kemp, Jr., A. N. Lilley, J. H. Pipkin, J. H. Ramblin, Jr., J. S. Worden, Vice-Presidents; Wallace E. Avery, Secretary; E. C. Breeding, Comptroller.

---

Vol. XLIII

December, 1957

No. 12

*Change of Address:* In reporting change of address kindly give both old and new addresses.  
*"The contents of 'LUBRICATION' are copyrighted and cannot be reprinted by other publications without written approval and then only provided the article is quoted exactly and credit given to THE TEXAS COMPANY."*

---

## PACKAGE RESEARCH

ALTHOUGH product and process research are long established activities in the petroleum industry, formalized package research is relatively new. At the turn of the century kerosine was the major product, with small amounts of gasoline and a few grades of straight mineral oils and greases. The nature of these products did not require special containers; thus, packaging was dictated only by convenience in distribution.

The situation today is entirely different. We are in a specialized age where large numbers of petroleum products have been developed with "tailor-made" properties. In addition, the petroleum companies have entered the field of petrochemicals and are faced with marketing all of these products in suitable packages. The complexity of the packaging requirements is further complicated, since each product may be marketed in several containers of different sizes.

The packages of today still serve as a convenient means of distribution, but consideration must now be given to other important aspects. Process and product research has resulted in premium products, and it is obvious that quality protection by the package is mandatory, or the consumer will not receive the full benefit of research developments. Many of the properties that are characteristic of the present products are due to the incorporation of

chemical compounds or additives. Consequently, the individual component parts of containers must neither affect the product nor be affected by it so that the customer will receive full measure of quality and quantity. Another point of consideration is cost. A great effort is made to find the most economical package components that are satisfactory for use with a particular product, in order to reduce the overall cost to the ultimate consumer. A further consideration in times of national emergencies is the use of non-critical materials.

The American Petroleum Institute's "Glossary of Packaging Terms" defines a package as a container which holds the product of sale, such as: a can, bottle, jar, collapsible tube, carton, drum, etc. It therefore follows that a petroleum company's package research program may encompass all forms of containers, including, in addition to the more conventional types of packages, railway tank cars, motor tank trucks, pipe lines, barges, and ocean-going tankers.

The primary consideration of the petroleum companies is to assure themselves that the refinery quality of their products is protected from contamination or loss during delivery to the customer. The discussion which follows, briefly describes the precautions that a petroleum company may take in this regard through its research efforts.

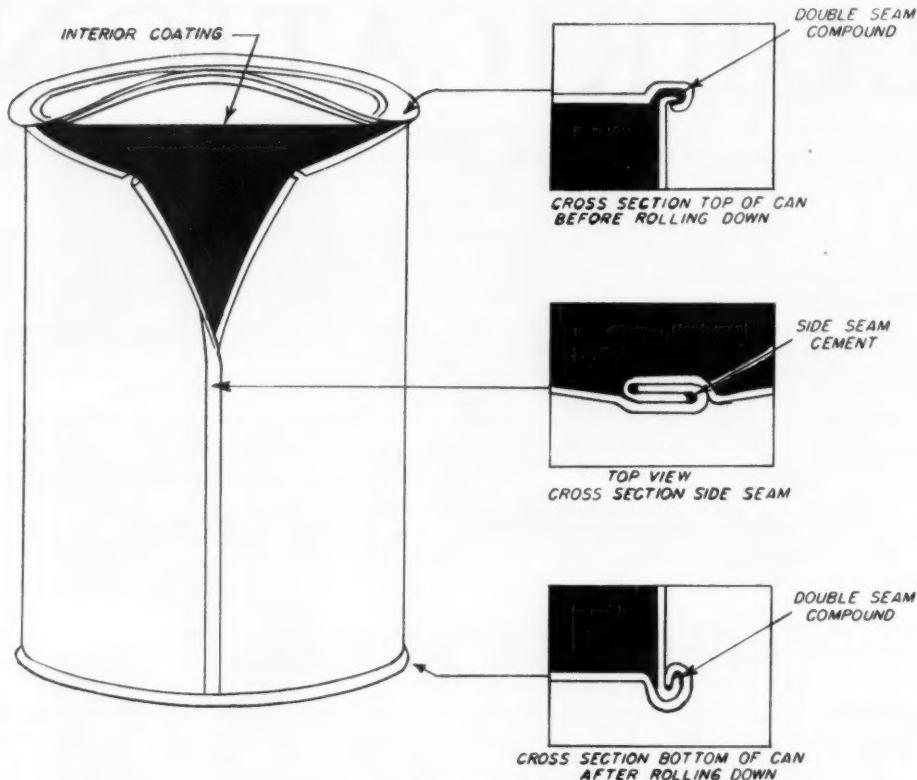


Figure 1 — Seam construction of a quart can.

### CONTAINER COMPONENTS

To paraphrase an age-old saying that "a chain is no stronger than its weakest link," a container is no better than its poorest component. The basic parts of the more familiar containers that are used in the petroleum industry for packaging lubricating oils are illustrated in Figure 1 by the exploded view of a one-quart can. A description of these components follows, with a brief discussion of the difficulties which may be encountered in the selection of suitable package components.

#### Container Metals

**Lubricating Oil Packages** — Containers may be made from plain steel, aluminum, galvanized steel, terneplate (lead-tin alloy plate), or tinplate. Ordinary steel plate is the most economical of these materials and is entirely satisfactory for packaging lubricating oils; however, there are certain problems associated with its use. For example, containers made from plain steel plate are subject to rusting before filling, due to contact with oxygen or

moisture. Therefore, an oil-insoluble organic coating is usually applied to the container interior in order to protect the metal surface from rust prior to filling with the product. The exterior may also be painted, enameled or lithographed to both decorate and protect.

**Chemical Specialty Packages** — Unlike lubricating oils, certain types of chemical specialty products and petrochemicals are mildly corrosive. Hence, if steel containers are used to package these products, interior coatings are required for the dual purpose of protecting the container both before and after filling. Uncoated steel containers are unsatisfactory, since they may corrode to the point of perforation of the metal with resultant loss of the product. A magnified general view of such a corroded area is shown in Figure 2 while Figure 3 presents a highly magnified view of a single complete perforation of pinhole size. The mechanism by which such perforation occurs is basically electrochemical in nature and involves the transfer of electrons from the positively (anodic) to the negatively (cathodic)

## LUBRICATION



Figure 2 — Example of container corrosion.

charged areas on the surface of the metal as illustrated in Figure 4.

Uncoated containers made from metals other than steel may also be subject to corrosion by certain chemical specialty products. This corrosion is often chemical in nature and may be continuous, wherein the corroded material is soluble in the packaged product and fresh metal is therefore continuously exposed to the corroding environment. In such instances, the packaged product will be contaminated with the soluble corroded material and may eventually be lost due to perforation of the container. This can be combatted by selecting a metal for the container that will develop a film that is insoluble in the corrosive medium. Protection of the metal from further corrosion is thus obtained through the physical barrier of the film that is formed as illustrated by Figure 5. When these containers are abused in service, however, there is a possibility that the product may be contaminated with flakes of the insoluble film.

One sure way of overcoming container corrosion and product contamination from this source, is to use expensive unreactive metals. Usually this solution is not economically feasible. A more attractive solution in most cases is the use of plain steel in combination with a suitable plastic coating.

### Interior Coatings

The many types of plastic coatings vary considerably in their individual characteristics. Some are readily softened or dissolved by petroleum products. They also differ markedly in their flexibility and resistance to moisture and to products that may be alkaline or acidic in nature. For example, an oleo-

resinous coating has excellent flexibility and is satisfactorily resistant within the pH range of most lubricating oils; however, if the product becomes contaminated with water the coating may soften excessively. An epoxy type coating is non-brittle and has excellent resistance to moisture and products that are alkaline in nature. On the other hand, a pure phenolic coating has excellent resistance to moisture and products that are slightly acidic, but it may be quite brittle. Consequently, phenolic coatings usually contain modifying agents to improve their flexibility. Usually a combination of an epoxy and phenolic coating will retain the desirable characteristics of both types of coatings and may be used with a variety of chemical specialty and lubricating oil products.

Regardless of the type coating used, it must be applied in a certain minimum thickness to insure a continuous protective film. If the coating has any breaks, or pinhole perforations, the exposed areas of the metal may become alternately positively and negatively charged. If the packaged product contains an electrolyte of any sort, an electrolytic cell may be formed and corrosion will occur by a similar mechanism to that illustrated in Figure 4, but more specifically depicted by Figure 6a. Corrosion reactions of this type are controlled by the size of the cathode. If the action occurring at the cathode loosens the bond of the coating to the surrounding metal surface, thus enlarging this area, the transfer of electrons from the anode will be increased and the container may eventually become perforated as shown in Figure 6b.

### Side Seams

As illustrated in Figure 1, four thicknesses of

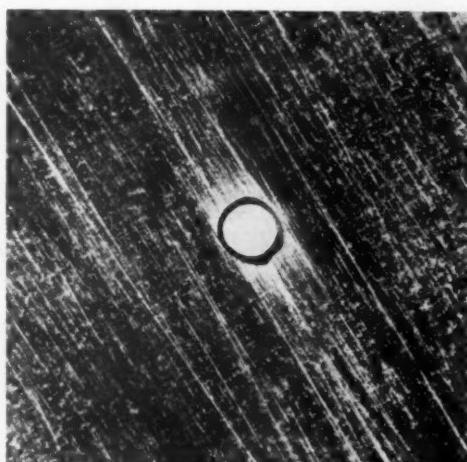


Figure 3 — Highly-magnified pinhole perforation.

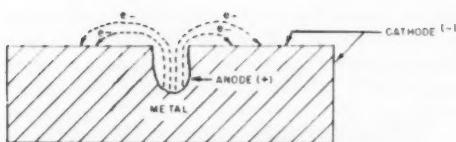


Figure 4 — Mechanism of electrolytic corrosion.



Figure 5 — Protection afforded by an insoluble corrosion film.

metal are usually rolled together to make the side seam, thus forming the cylindrical shell of the can body. These seams are made leak-proof by sealing with either solder or a polyamide resin. If soldered side seams are required, it is necessary to construct the containers from tinplate or terneplate, since solder will not adhere satisfactorily to bare steel unless strong fluxes are used, and these introduce the further problems of complete neutralization or removal. Furthermore, if an organic interior coating is also used, it may be damaged adjacent to the seam by the temperature necessary for proper application of the solder. Thus, an extra manufacturing step is required to repair this damage.

On the other hand, cemented side seam, or resin-sealed containers, may be constructed from any type plate. There are also no problems with damage to the interior coatings or outside lithography in the manufacture of containers of this type. Consequently, cemented side seam containers are more commonly used in the petroleum industry.

While at first glance it would appear that the cemented side seam can would not be as strong structurally as the soldered can, pressure tests have demonstrated comparable ability to withstand any expected internal pressure build-up that may occur during their storage life (Figure 7).

**TABLE I**  
**Types of Double Seam Compounds**

Neoprene
Buna S Rubber
GR-S Rubber
Nitrile Rubber
Acrylic Rubber

### Double End Seams

As shown in Figure 1, the container ends are attached to the body by double seams similar in construction to the side seam. However, a rubber-like sealing compound is inserted in each double seam as it is formed in order that the seams will be leak-proof after rolling down. Several types of rubber are used in the manufacture of these sealing compounds (Table I) and the properties of each can be modified or enhanced by the incorporation of various compounding ingredients. The resistance of these sealing compounds to petroleum products varies considerably. The type of oil is particularly significant as shown in Figure 8, and in some cases additive composition may also contribute to deterioration. There are numerous compounds available for these seams and it is essential that the correct material be selected for containers used to package specific products.

### OTHER TYPES OF CONTAINERS

Other conventional metal containers may differ from the one-quart can described in the foregoing paragraphs, in that they are larger, have removable lids, require heavier plate, use more viscous double seaming compounds or have welded side seams. In some instances a chemical treatment of the metal surface replaces the interior organic coatings.

One of the most important differences is that the larger containers are equipped with a reclosing feature for the benefit of the customers in dispensing the product. The component parts of a typical closure are shown in Figure 9. Each individual part of the closure must be resistant to attack or swelling in the presence of the packaged product. The closure itself must be leak-proof and provide an adequate seal against ingress of air or moisture.

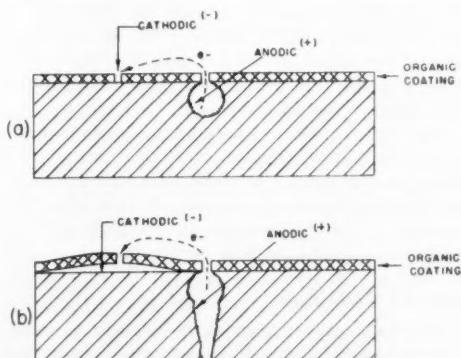


Figure 6 — Corrosion through an imperfect coating.

### SELECTION OF COMPONENTS

The selection of individual components for a

## LUBRICATION



Figure 7 — Pressure testing of one quart cans.

single container for a new lubricating oil that has a composition similar to products packaged in the past, is relatively simple. On the other hand, when several types of containers are involved, and the composition of the new product is drastically different from those with which past experience has been gained, the process becomes more complicated. It is then necessary to determine the effect of each component of every container upon the product and conversely, the product upon each component.

One significant factor to be considered in this regard is the abuse to which the filled containers may be subjected during handling and the possible resultant product contamination. In the case of the 55-gallon drum, hot rolled steel plate is used for its construction. Normally, plate of this type is covered with a brittle film of millscale that is likely to flake off into the product upon moderate deformation of the drum. As a means of preventing this contamination, the millscale may be removed dur-



Figure 8 — Effect of various base oils on a sealing compound.



Courtesy of American Flange & Manufacturing Co., Inc.

Figure 9 — Component parts of a typical closure.

ing manufacture of the drum by some means such as acid pickling or shot blasting. This step is immediately followed by a chemical treatment that inhibits the surface against rust. Drums made from this type of plate have proven to be very satisfactory in service, and are gaining widespread usage for packaging petroleum products. Figure 10 illustrates the interior cleanliness of a drum of this type after "drop testing."

In the case of smaller containers, care must be taken to select an interior coating that will not lose its flexibility and flake off into the product. An example of a coating that has become brittle and would contaminate the product if the container is abused is shown in Figure 11.

Another important factor to be considered is the environmental conditions to which the packaged lubricants will be subjected. For example, they may stand for months in warehouses at elevated temperatures, or in the open, exposed to all sorts of weather conditions. Many seaming compounds that are otherwise satisfactory are deteriorated after a few weeks at higher temperatures. When the containers are stored in the open, moisture may enter through the closures during repeated dispensing of the product, and this may cause degradation of the interior coatings and seaming materials. All of these factors are considered in selecting container components for a new lubricant.

### Typical Case History

To better illustrate the process of selecting suitable package components, the development of typical container specifications for a new lubricating oil product will be described.

The first step is to determine the types of containers in which the product will be marketed. This decision is based upon the intended purpose of the lubricant and its expected volume of sale. An individual lubricating oil product may be marketed in several types of containers; however, since 55 and 5-gallon drums and 1-quart cans are the most widely used, it will be assumed that the new product will be marketed only in these packages.

After this decision has been made, each container is considered on the basis of individual parts. The reaction of many container components with a new formulation can be reasonably predicted from past experience; however, this may not be true if the composition of the new product is drastically different. Accordingly, several different materials for each application are evaluated in a preliminary testing program. In a typical case, this usually involves 3 months storage of the materials in contact with the product at elevated temperatures. The package materials are observed for deterioration and complete tests are also obtained on the product at regular intervals throughout this period to check against possible quality degradation.

Some of the materials studied in a typical screening program of this type are shown in Table II, together with the actual observed condition at the end of a preliminary storage program. This list of materials would be either expanded or reduced depending upon the number and types of containers to be used in marketing the product.

From the data developed in preliminary programs of this type, tentative specifications are developed for each container to be used as shown in Table III. In this case, chemically treated plate was specified for the 55-gallon drum, because of the combination



Figure 10 — Interior of a chemically-treated drum after drop testing.

## LUBRICATION

**TABLE II**  
**Typical Screening Program**

Container Components	Condition
<i>Container Metals</i>	
(1) Hot rolled steel	Slightly rusted
(2) Cold rolled steel	Slightly rusted
(3) Chemically treated steel	Unaffected
(4) Galvanized steel	Unaffected
(5) Aluminum	Unaffected
(6) Tinplate	Unaffected
<i>Interior Coatings</i>	
(1) Phenolic	Slightly brittle
(2) Oleoresinous	Unaffected when dry (deteriorated in presence (of water))
(3) Epoxy	Unaffected
(4) Epoxy-phenolic	Unaffected
<i>Seaming Materials</i>	
(1) Double seam compound A	Deteriorated
(2) Double seam compound B	Unaffected
(3) Double seam compound C	Softened
(4) Double seam compound D	Unaffected
(5) Soldered side seam.	Unaffected
(6) Side seam cement A	Unaffected
(7) Side seam cement B	Softened
(8) Welded side seam	Unaffected
<i>Closures</i>	
(1) Zinc die cast plug assembly	Unaffected
(2) Cast iron plug assembly	Slightly rusted
(3) Cadmium plated plug assembly	Unaffected
(4) Polyethylene push-pull spout assembly	Unaffected
(5) Non-extendable steel plate closure	Unaffected



Figure 11 — A brittle drum coating after drop testing.

**TABLE III**  
**Tentative Specifications**

*55-Gallon Drum*

Container Metal:	Chemically treated steel plate
Interior Coating:	None
Seaming Compound:	Double seam B Welded side seam
Closure:	Zinc die cast plug assembly

*5-Gallon Drum*

Container Metal:	Cold rolled steel plate
Interior Coating:	Epoxy-phenolic
Seaming Compound:	Double seam B Welded side seam
Closure:	Polyethylene push-pull spout assembly

*1-Quart Can*

Container Metal:	Cold rolled steel plate
Interior Coating:	Oleoresinous
Seaming Compounds:	Double seam compound D Side seam cement A
Closure:	None



A. New method



B. Old method

Figure 12—Application methods for traction motor gear lubrication.

of its rust-resistant surface and freedom from mill-scale. An organic coating was therefore not required, and contamination of the product with flakes of millscale was eliminated. Cold rolled steel plate is universally used in combination with suitable organic coatings for small containers in the petroleum

industry and is the proper selection in this case for the 5-gallon drum and 1-quart can. Since the 5-gallon drum is equipped with a reclosing feature through which air and moisture may enter during times the product is being dispensed, an epoxy-phenolic coating was specified due to its moisture resistance and flexibility. The more economical oleoresinous coating was used for the 1-quart cans, since the product is entirely consumed after a single opening and moisture contamination is no problem.

The seaming compounds and closures selected were unaffected in the presence of the product. This is always essential in order to avoid container leakage or contamination of the product with traces of moisture.

## TESTING OF FINISHED CONTAINERS

### Laboratory Tests

After development of the tentative specifications, finished containers meeting these requirements are ordered for further testing. These containers are filled with the product and stored at both ambient and elevated temperatures. Containers equipped with reclosing features are also stored with products that have been saturated with water. During the course of the storage, a continuing check is made upon the quality of the product in order to confirm preliminary data developed with the single components.

Other filled containers are "abuse tested" under the most extreme handling conditions, after which the interior surfaces are examined for damage and the products observed for contamination. In the event a new type of closure is contemplated, extensive tests are conducted in order to determine its ability to prevent loss of product or moisture ingress over a wide range of temperature conditions.

### Field Tests

Although laboratory tests are useful in the development of a new lubricating oil formulation and the selection of components for the containers in which it will be marketed, field conditions often impose demands upon both the lubricant and the package that cannot be foreseen or duplicated in the laboratory. Therefore, before a new lubricant is marketed, it is tested under actual field conditions. The tentatively approved containers are used to package the product for this final test program, during which the performance of the containers is observed as critically as the lubricant itself.

## CONVENTIONAL GREASE CONTAINERS

The foregoing has dealt with conventional metal containers for lubricating oils, petrochemicals and

## LUBRICATION



Figure 13 — Plastic tube for outboard motor gear oil.

chemical specialty products. The conventional metal containers used for packaging greases may sometimes be constructed with identical components to those used for lubricating oils. The major difference is that grease containers have removable lids. Similar problems are faced in establishing suitable components for these containers as those previously discussed, and the same techniques are employed to insure protection of the quality of the product when it reaches the customer.

### Special Grease Containers

Packaging of greases extends beyond the field of metal containers. In order to facilitate application, special packages are used for some products that would otherwise be difficult to dispense. For example, traction motor gear lubricants are generally heavy, black and tacky, and the refill holes of the gear boxes on diesel locomotives are small and relatively inaccessible. Because of this, the addition of make-up lubricant to the gear cases, is generally a difficult and dirty assignment.

Several methods have been proposed for packaging these lubricants which would be more convenient to maintenance men. Probably the method that is receiving the most attention is to package the lubricant in soft sealed plastic bags which are clean to handle, prevent contamination of the lubricant and can be simply dropped into the gear case. The plastic itself is macerated during the subsequent meshing

of the gears and becomes part of the grease. The advantages of this type packaging are illustrated in Figure 12, which shows the more convenient application of make-up lubricant that has been packaged in a plastic bag, in comparison to the method previously used.

A considerable amount of experimental work has been conducted with this type packaging. The permeation of the product through many different types of plastic films had to be determined. It was also necessary to determine the effect upon product performance, since in service the plastic bag would be ground into the lubricant by the gears. Laboratory tests that simulated service under field conditions were used in this latter study. After selection of the most suitable film, it was desirable to determine how completely the bags would be macerated by the gears and if lubrication problems would be created. A diesel locomotive was lubricated over a period of one year with a lubricant packaged in a plastic bag. These tests have indicated that packaging of this type is entirely satisfactory from a product performance standpoint.



Figure 14 — Adaptability of pressure-resistant plastic tube for outboard motor gear grease.

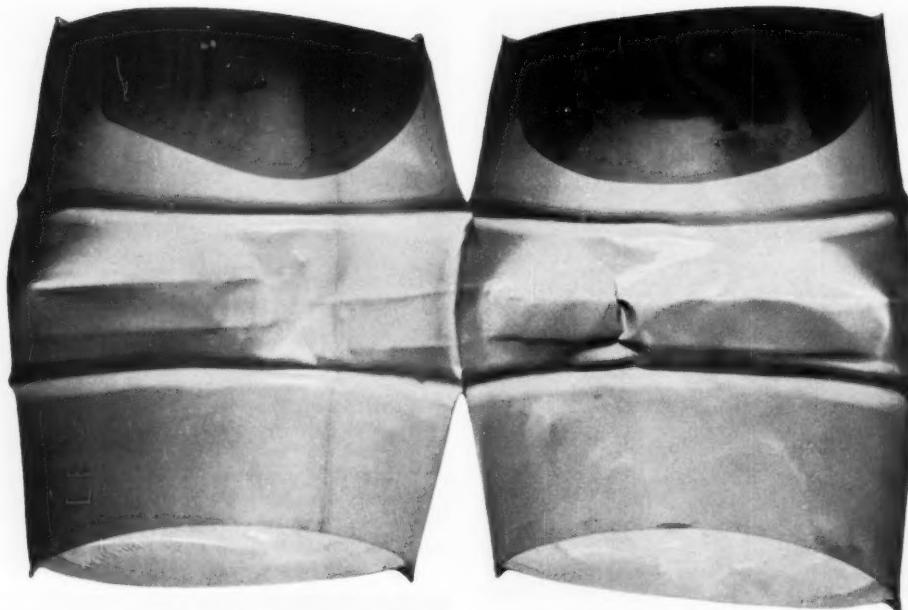


Figure 15 — Test drum lined with a good tank car coating.

Plastic bags made from impermeable film are also being used in combination with other packages. Cardboard cases lined with these bags are presently being successfully used to package cake greases. It was previously necessary to package products of this type in cases made from wood. Some work has also been conducted with plastic bags as interior liners for drums made from fiber board. In the event of a national emergency, whereby steel becomes scarce, it is entirely possible that greases will be marketed in this type container.

The use of plastics in the package industry is increasing and it is only natural that plastic containers with their inherent advantages are being adopted more and more for packaging of petroleum products. For example, the more common metal tubes that are used for outboard motor gear lubricants are not sufficiently pliable and sometimes split in service with a resultant loss of product. More suitable containers have been desired for some time for products of this type, but a superior package was not within reach until similar tubes made from plastics came on the scene.

The earlier plastic tubes were unsuitable for this application due to oil permeation. Subsequently, plastic tubes with interior linings that prevent oil permeation, have been developed by container manufacturers as illustrated in Figure 13. Tests conducted with tubes of this type have indicated that they are also entirely suitable for packaging greases.

It has also been shown that plastic tubes may withstand external pressure of up to 20 times more than some metal tubes of the same capacity. Consequently, they have been adopted for use in the petroleum industry as illustrated in Figure 14.

#### TANK CARS AND TANK TRUCKS

It is the practice in the petroleum industry to deliver bulk shipments to large consumers in tank trucks or railroad tank cars. In the past, difficulty has been encountered with contamination of shipments with flakes of rust from the interior of these transports. This rusting has usually taken place on

**TABLE IV**  
*Typical Products Transported in Bulk*

Gasolines	Turbine Oils
Kerosines	Refrigerator Oils
Diesel Fuels	Transformer Oils
Jet Fuels	Motor Oils
Furnace Oils	Automatic Transmission Fluids
Railway Diesel Oils	Petrochemicals

## LUBRICATION



Figure 16 — Supposed mechanism by which antirust inhibitors function.

return trips when the tanks are empty and the interior metal surfaces are exposed to moisture and oxygen from the enclosed air.

One method used by many petroleum companies to insure delivery of uncontaminated products is to thoroughly clean and inspect each tank before filling. Usually, the rust that has formed cannot be removed by conventional cleaning procedures, and it must be removed manually. This method is both time-consuming and expensive.

The trend in the petroleum industry is to eliminate this expense of manual cleaning by putting tanks into service that have been lined with organic coatings. Thus the interior surfaces are protected from rusting and the transports may then be rushed back into service after a routine steam cleaning procedure and inspection.

The same tank car or truck may be used to transport different products at different periods of time (Table IV). It therefore stands to reason that the organic coatings used for this application must be more durable and resistant than those used for protection of smaller containers that are designed for a single product. These coating materials must also withstand the high temperatures associated with steam cleaning procedures and must be resistant to shock and abrasion. In addition, the coatings are required to retain these properties in the presence of a variety of oil types and additive compositions.

Many organic compositions are available for this application. They are usually thermosetting resins which require baking for a period of time at temperatures near 400°F. Catalysts may be used with some types instead of employing high baking temperatures. The coatings may contain different solids which modify or enhance their properties. In such cases, it is desirable that the solid be a light colored material since this will facilitate inspection of the transport for cleanliness.

Before a coating is approved for use as a transport lining, considerable testing is conducted. Usually the first step involves screening of coated metal strips immersed in a representative group of products. The materials passing this initial test may then be applied, preferably by the coating manufacturer, to small containers, such as 55-gallon drums, for convenience in further testing.

These drums are then subjected to tests that would typify service conditions of lined transports. Some are filled with products and stored at extreme

temperature in a quiescent state while others are constantly agitated to simulate movement in transit. Several filled drums are dropped repeatedly from a height of several feet and then emptied and cut open to check the adhesion of the coating as shown in Figure 15. Product quality is also checked at regular intervals during all of these tests. Finally, the test drums are cleaned using cleaning procedures that may be used on transports. The coatings which satisfactorily withstand this combination of testing and abuse may then be used on a trial basis in transports, pending a final decision on their suitability.

## PIPE LINES AND MARINE TANKERS

Pipe lines and tankers are primarily used to transport gasoline in bulk quantities. Due to the nature of transportation, contact with oxygen and water is greater than for conventional packages, and serious rusting of the internal surfaces may occur. Cleaning of these systems is a major expense, to say nothing of the loss in operating time and early replacement of corroded sections. Should the product be contaminated with rust flakes during transit, filtration at the point of delivery may be necessary.

Several methods have been investigated to protect

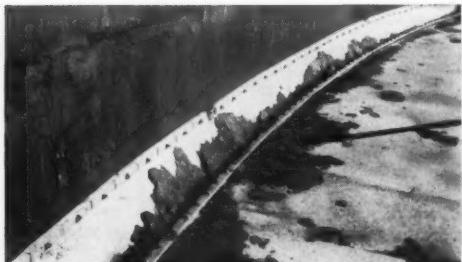


A. Before product inhibition

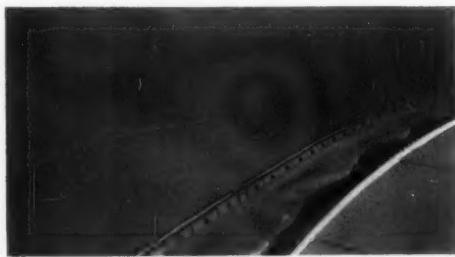


B. Two and one-half years after product inhibition

Figure 17 — Effect of antirust inhibitor on product pipeline interior.



A. Uninhibited gasoline



B. Inhibited gasoline

Figure 18 — Effect of antirust inhibitor on refinery storage tank interiors.

products against this source of contamination. Many paints and organic coatings have been tried. Generally, coatings are too expensive, and may not adhere satisfactorily, since in actual practice they are difficult to apply to these systems. Probably the method that has been gaining the most favor in the petroleum industry is the use of product-soluble rust inhibitors. In fact, the addition of approved anti-rust inhibitors is required in military aviation gasolines and jet fuels. One type of material that may be used consists of chain hydrocarbon compounds which contain polar-functional groups. The supposed mechanism by which these compounds function is illustrated in Figure 16, which shows the polar groups bonded to the metal in close alignment. Products that contain suitable rust-inhibitors therefore create their own "coating" which isolates the metal surface from rusting and thereby protects product quality.

The effectiveness of materials of this type varies considerably, since the attachment to the metal surface may range from a weak physically adsorbed film to a strong chemical bond. Thus, one of the most important steps in the development of a suitable anti-rust compound is to design laboratory tests that will demonstrate the effectiveness of the inhibitor under actual field conditions. Tests have been developed which simulate flow conditions in

a pipeline and conditions existing in a tanker compartment. The data developed from these tests reasonably agree with corrosion rates encountered with uninhibited products in the field.

Although an inhibitor with very good anti-rust properties may be developed, it is possible that it may be detrimental to product performance. For example, it is conceivable that an anti-rust inhibitor might increase the gum content of gasoline, or contribute to fouling of spark plugs, valves, carburetors, and intake manifolds. Therefore, it is necessary to conduct extensive laboratory tests, followed by full scale field tests, to determine the performance of the inhibited products before an inhibitor can be approved for use.

The effectiveness of inhibitors in reducing rusting in pipe lines is illustrated in Figure 17. The upper photo shows the condition of the interior surface of a section of pipeline before inhibition began, the lower after two and one-half years' service with the inhibited product. Anti-rust inhibitors are also effective in reducing contamination of the product with rust from refinery, service station, and customer tankage. This is illustrated by Figure 18a which shows the interior of a tank used for storing uninhibited gasolines in comparison to Figure 18b which illustrates the interior of a tank used for storing inhibited gasolines. Any bare iron parts in the gasoline tanks and fuel systems of passenger cars and trucks are also protected by the use of effective rust inhibitors in fuels.

The preceding only touches on the subject of pipeline and tanker corrosion and the protection of products from these sources of contamination. It is a matter that is receiving considerable attention in the petroleum industry, both from the standpoint of product quality and economics.

## SUMMARY

The development of suitable packages for today's petroleum products is a complicated but necessary process. The conventional metal containers may be constructed from several types of "plate" in combination with a number of sealing compounds and interior coatings. In addition, the containers are available in many sizes and often are equipped with different types of closures for convenience in dispensing the product. It is essential that each package component be compatible with the product, since the container has the responsibility of delivering the original product quality to the consumer. It is therefore necessary to establish satisfactory container components for each product. This is accomplished by Package Research which has become an integrated part of the overall research program of many petroleum companies.

---

# LUBRICATION INDEX

*for*

VOLUME 43, 1957

MONTH	SUBJECT	PAGE
JANUARY	MICROCHEMISTRY IN LUBRICATING OIL ANALYSIS . . . . .	1
FEBRUARY	ABRASIVES AND WEAR . . . . .	13
MARCH	ADDITIVES WITH A PURPOSE . . . . .	25
APRIL	SOLUBLE OIL EMULSIONS, SPENT Disposal of . . . . .	41
MAY	SURFACE MINING EQUIPMENT New developments in . . . . .	49
JUNE	EXTREME PRESSURE LUBRICANTS . . . . .	65
JULY	HIGHWAY CONSTRUCTION EQUIPMENT Lubrication of . . . . .	77
AUGUST	AUTOMATIC GREASE DISPENSING EQUIPMENT	93
SEPTEMBER	PORTABLE AIR TOOLS Lubrication of . . . . .	105
OCTOBER	CEMENT MILL LUBRICATION . . . . .	113
NOVEMBER	LUBRICATION SYSTEMS, CENTRAL AIR-BORNE	125
DECEMBER	PACKAGE RESEARCH . . . . .	133

\* \* \* \*

---



## It's "in the bag" for easy application ... Texaco Crater

Texaco Crater is now available in 1-lb. polyethylene bags—48 bags to the case—clean, convenient, economical. This is the same reliable product that has long been giving traction motor gears outstanding protection in all types of Diesel gear cases. But now—make-up servicing is so fast and easy—just drop in bag and all.

Time and again, comparative road tests have proven that Texaco Crater gives more miles per pound. Now, with in-the-bag application,

over-all lubricating costs can be lowered, too—because in over-the-pit servicing, it's easy to control quantity, eliminate all waste, sharply reduce application time.

For full information, call the nearest Texaco Railway Sales Office in New York, Chicago, San Francisco, St. Paul, St. Louis, or Atlanta. Or write: The Texas Company, *Railway Sales Division*, 135 East 42nd Street, New York 17, New York.

### THE TEXAS COMPANY • • • DIVISION OFFICES

ATLANTA, GA.....864 W. Peachtree St., N.W.  
BOSTON 16, MASS.....20 Providence Street  
BUFFALO 5, N. Y.....P.O. Box 368  
BUTTE, MONT.....220 North Alaska Street  
CHICAGO 4, ILL.....332 So. Michigan Avenue  
DALLAS 2, TEX.....311 South Akard Street  
DENVER 3, COLO.....1570 Grant Street

SEATTLE 1, WASH.....1511 Third Avenue



HOUSTON 2, TEX.....720 San Jacinto Street  
INDIANAPOLIS 1, IND., 3521 E. Michigan Street  
LOS ANGELES 15, CAL....929 South Broadway  
MINNEAPOLIS 3, MINN.....1730 Clifton Place  
NEW ORLEANS 16, LA.....1501 Canal Street  
NEW YORK 17, N. Y.....205 East 42nd Street  
NORFOLK 2, VA.....3300 E. Princess Anne Rd.

Texaco Petroleum Products are manufactured and distributed in Canada by McCall-Frontenac Oil Company Limited.